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OXYGEN AND AIR CONTROLLING APPARATUS FOR AVIATORS

Filed Aug. 28, 1943

2 Sheets-Sheet 1

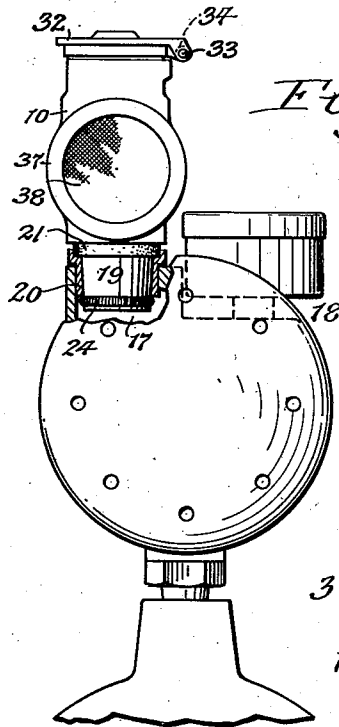


Fig. 1.

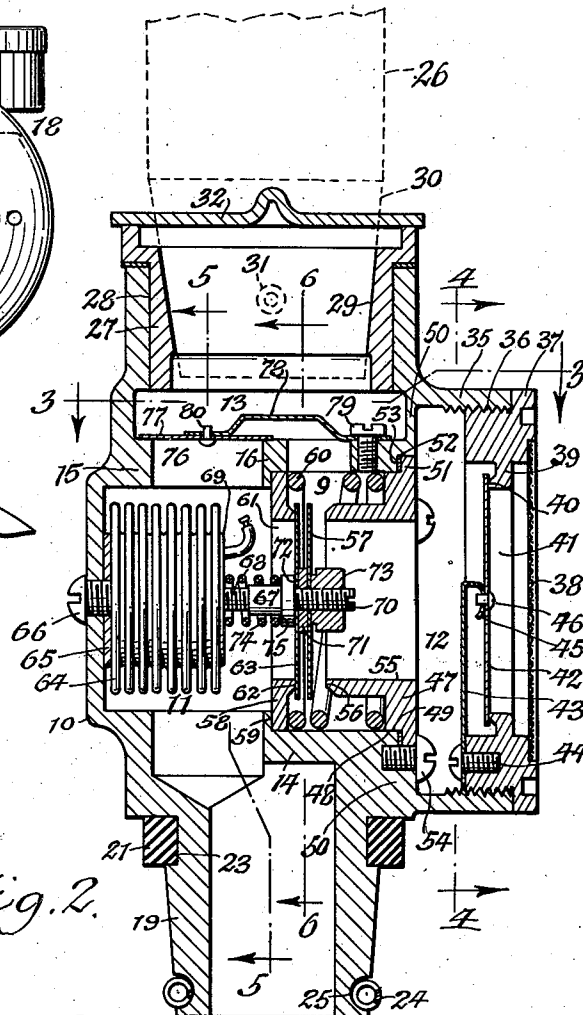


Fig. 2.

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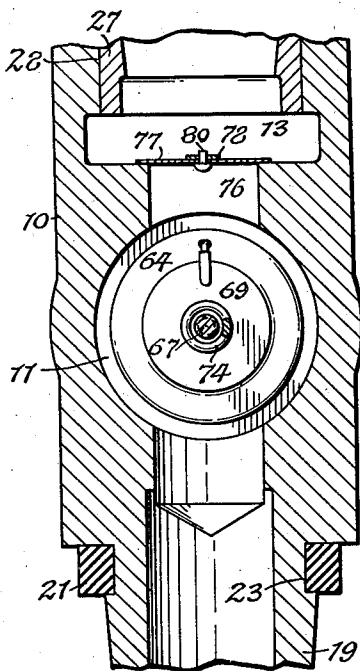
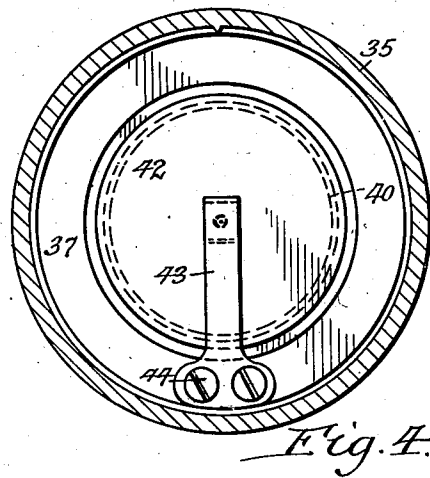
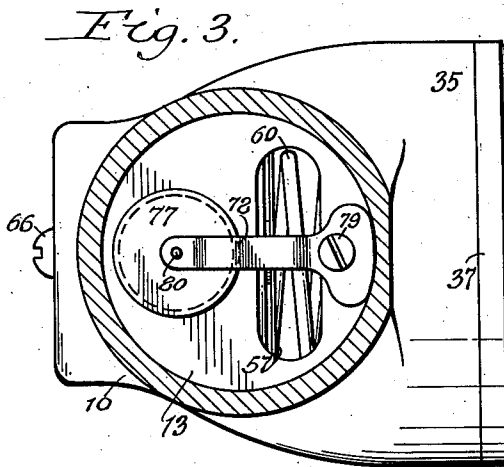


Fig. 5.

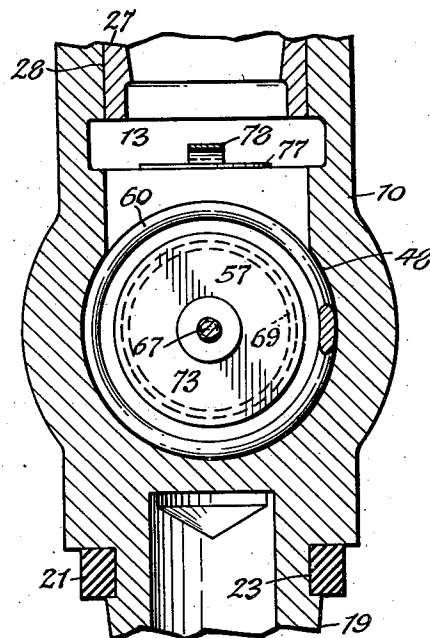


Fig. 6.

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UNITED STATES PATENT OFFICE

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OXYGEN AND AIR CONTROLLING
APPARATUS FOR AVIATORS

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4 Claims. (Cl. 137-153)

This invention relates to an air and oxygen controlling apparatus for varying the proportion of air and oxygen in the breathing mixture which is supplied to aviators at various altitudes.

In its preferred form this invention is constructed as a separate unit which may be used in connection with any standard form of emergency walk-around oxygen bottle breathing apparatus and regulator assembly, such, for example, as that shown in application for United States Patent Ser. No. 466,165, filed November 19, 1942, to which reference may be had for a detail description.

When the aviator is on ground level he requires no extra oxygen in addition to that contained in the ordinary atmosphere and when flying at relatively low altitudes the requirement for extra oxygen is still comparatively small. When, however, flying in the higher critical altitudes the breathing mixture must contain a much larger percentage of oxygen to insure the safety of the aviator.

It has been found that air and oxygen mixing devices, as heretofore constructed, supplied a mixture which is too rich for low altitudes when the device was adjusted very close to the critically high altitudes where a man must have from 98% to 100% oxygen and at a point where his oxygen tolerance is very small, which conditions have not been completely taken care of heretofore. A deficient mixing device when operated at an altitude of about 35,000 feet could very easily, through some maladjustment or failure, cost the life of the aviator, taking into consideration that the present oxygen tolerance, at an altitude of between 35,000 feet and 37,000 feet is considered to be only between 35 and 60 seconds. It is therefore very important in the mixing of air and oxygen that the mixing unit works positively without failure at this critical altitude and still permit of greater economy in supplying oxygen at the lower altitudes.

It is therefore the object of this invention to provide an air and oxygen mixing device for aviators whereby a breathing mixture is supplied at low altitudes which is not too rich in oxygen and this effects greater economy in the use of the same, while upon reaching higher altitudes an increased amount of oxygen is supplied in proportion to the decreasing oxygen tolerances.

In the accompanying drawings:

Fig. 1 is an elevational view of the air mixing device embodying this invention shown in connection with a standard breathing apparatus.

Fig. 2 is a vertical longitudinal section, on an enlarged scale, of this mixing device.

Fig. 3 is a horizontal section, on line 3-3, Fig. 2.

Figs. 4, 5 and 6 are vertical transverse sections, taken on the correspondingly numbered lines in Fig. 2.

In the following description like reference characters indicate the same parts in the several figures of the drawings.

The numeral 10 represents the body or shell of the air and oxygen mixing device which is preferably formed in one piece and provided internally with an oxygen inlet chamber 11 arranged in the lower part of the body, an air inlet chamber 12 arranged on one side of the intermediate part of the body, an air and oxygen mixture outlet or respiration chamber 13 arranged in the upper part of the body, and a vertical transfer passage 9 arranged between the oxygen inlet and air inlet chambers and opening at its upper end into the mixture outlet chamber and practically forming part of the latter. These several chambers are separated from each other by partition means which comprise a horizontal lower wall 14, a horizontal upper wall 15 and a vertical wall 16 arranged in the central part of the body.

The oxygen inlet chamber may be connected in any suitable manner with a source of oxygen supply. The means for this purpose shown in the drawings are more particularly intended for connecting this chamber with the oxygen outlet 17 of the breathing apparatus 18 forming the subject of said patent application. As there shown the body 10 of the mixing apparatus is provided on its underside with a vertical tubular neck 19 which communicates with said oxygen inlet chamber 11 and has a downwardly tapering exterior adapted to fit in a correspondingly shaped bushing 20 arranged in the outlet 17 of the breathing apparatus 18. A tight joint is produced between this inlet neck 19 and the bushing 20 by a gasket 21 arranged in an annular groove 23 on the upper part of the periphery of the neck and engaging with the upper end of the bushing and an annular coiled locking spring 24 arranged in an annular groove 25 on the lower part of the periphery of this neck and engaging with the lower end of this bushing, as shown in Figs. 1 and 2.

Oxygen or the mixture of oxygen and air is delivered from the outlet chamber 13 to the mask of the aviator by an inhaling tube 26 which is detachably connected with the mixture outlet

chamber by a tubular coupling bushing 27 secured in a circular opening 28 on the upper part of the body 10 and having a downwardly tapering conical seat 29 which is engaged by a tapering nozzle 30 on the inhaling tube, as shown in Fig. 2. The bushing 27 is held in place on the body 10 by a set screw 31, preferably of the Allen type. When this air and oxygen mixer is not in use the upper or outer end of the coupling bushing is closed by a cover 32 which is connected therewith by a hinge 33 and yieldingly held shut by a spring 34.

Valve means are provided whereby external air is admitted to the air inlet chamber whenever the pressure within this chamber drops below atmospheric pressure but exclude such air at other times, which valve means are preferably constructed as follows:

The numeral 35 represents a circular wall which projects laterally from the central part of the valve body and forms part of the enclosure for the outer part of the air inlet chamber 12. Within the outer part of this circular wall is arranged a valve ring 36 which is detachably connected therewith by cooperating screw threads formed respectively on the periphery of this ring and the bore of said circular wall, and said ring having a peripheral flange 37 on its outer side which bears against the outer end of said wall. Across the outer side of the valve ring 35 a fine screen or filter 38 is secured which intercepts any particles of dirt, dust or foreign material in the air and permits only dust-free air to pass from the exterior of the apparatus into the air inlet chamber.

Within the bore of the valve ring 36 the same has an annular flange 39 which is provided with an inwardly facing annular valve seat 40 which surrounds the port or passage 41 in the center of this flange. The numeral 42 represents a main air check or inlet valve arranged in the air inlet chamber and having the form of a circular disk adapted to move with its peripheral edge portion into and out of engagement with the air valve seat 40. This air check valve disk is made of very thin, light and flexible material so that it is very sensitive and will quickly respond to any variation in pressure against the outer and inner sides of the same. This air valve disk is also very delicately mounted on the valve ring 36 so that it practically floats and responds immediately to any pressure differences against the opposite sides of the same. For this purpose spring means are provided for supporting the air valve disk which include a thin and light spring arm 43 arranged radially in the air inlet chamber relative to the axis of the air valve disk and connected at its outer end to the valve ring 36 by means of a screw 44 and having its inner end bent reversely in the form of a lip, as shown at 45 in Fig. 2, and connected by a pin 46 to the central part of the air valve disk.

Controlling valve means are provided whereby oxygen is caused to flow from the oxygen inlet chamber to the outlet chamber with or without admixture therewith of air in accordance with the pressure differential existing between the interior and exterior of this instrument and the respiring effect of the aviator at various altitudes.

These controlling valve means in this preferred form are constructed as follows:

The numeral 47 represents a valve ring which has a cylindrical periphery 49 engaging with a

cylindrical seat 48 formed in a wall 50 between the air inlet chamber 12 and the passage 9 and also has a cylindrical flange 51 on its outer side which bears through the medium of a gasket 52 against a circular shoulder 53 formed on the outer side of this wall concentrically with the periphery 49, as shown in Fig. 2. This valve ring 47 is secured to this wall by screws 54 screwed into the outer side of this wall and having their heads overhanging the outer side of this valve ring. A circular air port passage 55 extends concentrically through this air valve ring from the air inlet chamber to the passage 9 and on its inner side this ring is provided with an annular auxiliary air valve seat 56 which is concentric with this port.

The numeral 57 represents an auxiliary air valve which is arranged in the passage 9 and preferably has the form of a disk made of thin, light, flexible material so as to reduce its weight to a minimum and is movable with the outer side of its peripheral edge portion toward and from the auxiliary air valve seat 56 so as to control the flow of air from the air inlet chamber into the passage 9 and into the mixture outlet chamber 13. The movement of this auxiliary air valve is effected by means which respond to the demand of the aviator and the differential in pressure between the exterior and interior of this instrument as will later appear.

The numeral 58 represents a circular oxygen valve ring which is arranged in the transfer passage 9 and engages its periphery with the cylindrical bore 48 forming part of the wall of the transfer passage 9 and bears with its outer side against an inwardly facing annular shoulder 59 formed on the partition wall 16 concentrically with the valve disk 57. This oxygen valve ring 58 is held against this shoulder 59 by means which consist of a spacer 60 which is interposed between the peripheral parts of the auxiliary air valve ring 47 and the oxygen valve ring 58 and preferably has the form of a helical spring, as shown in Figs. 2 and 6. In its central part this oxygen valve ring is provided with an oxygen port or passage 61 extending from the oxygen inlet chamber 11 to the transfer passage 9 and on its inner side around this port the oxygen valve ring is provided with an annular valve seat 62 which faces inwardly or toward the transfer passage.

The numeral 63 represents an oxygen valve arranged in the transfer passage 9 adjacent to the auxiliary air valve 57 and preferably having the form of a disk made of thin, light, flexible material and movable with the outer side of its peripheral part toward and from the oxygen valve seat 62.

Controlling means are provided for actuating the auxiliary air valve disk and the oxygen valve disk simultaneously in response to variations between the pressure in the oxygen inlet chamber and the pressure in the mixture outlet chamber. In their preferred form these controlling means are constructed as follows:

The numeral 64 represents an aneroid, having preferably the form of a flexible accordion-shaped bellows or box from which the air has been partially exhausted, and which is arranged in the oxygen inlet chamber with its axis horizontal and in line with the axes of the oxygen and air valve disks and their respective valve seats. This aneroid has its outer head 65 secured by a screw 66, or otherwise, to that outer

wall of the valve body which is arranged opposite to the main air inlet valve mechanism while the inner end of this aneroid is arranged adjacent to the respective side of the port 61 in the oxygen valve ring, as shown in Fig. 2.

The numeral 67 represents a valve stem arranged axially in line with the aneroid and the oxygen and air valve disks and having a screw threaded outer end 68 which works in a threaded socket in the inner head 69 of the aneroid so that the valve stem can be adjusted lengthwise relative to the aneroid for a purpose which will presently appear.

Upon the inner end 70 of the valve stem both the oxygen valve disk and the auxiliary air valve disk are mounted so as to be movable axially with the stem when the latter is actuated by the operation of the aneroid in response to changes in pressure which affect the aneroid. Although these valve disks may be mounted on the valve stem in any suitable manner, it is preferable to pass this stem through openings formed centrally in the disks and through a spacing washer 71 between the same, and engaging the outer side of the oxygen valve disk with an inwardly facing shoulder 72 on the valve stem and engaging the inner side of the auxiliary air valve disk by a screw nut 73 which engages a screw thread on the inner end 70 of the valve stem and serves to securely clamp these valve disks on the stem and compel them to move in unison. By turning the valve stem the same can be moved inwardly or outwardly relative to the aneroid and bring the oxygen and auxiliary valve disks into the desired relation to the aneroid and the oxygen and auxiliary valve seats. After such adjustment has been effected the valve stem and the aneroid and the oxygen and auxiliary air valve are locked in position relative to one another by a detent device which preferably consists of a locking or detent spring 74 of helical form surrounding the inner part of the valve stem and bearing at its outer end against the inner head 69 of the aneroid while its inner end bears against an outwardly facing shoulder 75 on the valve stem.

Relief means are provided for increasing the percentage of oxygen in the mixture in case of emergency as will be described later on, which relief means preferably comprise a relief passage or port 76 extending through the top wall 15 from the oxygen inlet chamber to the mixture outlet chamber, a light disk-shaped valve 77 movable toward and from a position in which it covers or uncovers said relief port at the upper side of the same, and a light spring having the form of an arm 78 which has one end connected by a screw 79 with an adjacent part of the partition while its opposite end is connected with the upper side of the central part of the valve 77 by a pin 80, as shown in Figs. 2 and 3. It is important that the aneroid assembly and the oxygen and auxiliary air valve seats are concentric so that the respective valves will engage squarely with the same at an altitude of approximately 33,000 feet and prevent any leakage of oxygen into the outlet chamber at low altitudes as well as preventing leakage of air into the outlet at higher altitudes.

When using this apparatus it is desirable to so adjust the aneroid that at ground level the same will be under a slight tension or tendency to contract and thus hold the oxygen control valve 63 shut and the auxiliary air valve 57 wide open until the aviator reaches an altitude of, say, between 5,000 and 10,000 feet. As the altitude exceeds 10,000 feet the oxygen valve 63 begins to

open and the auxiliary air valve 57 begins to close and when an altitude of approximately 33,000 feet has been reached the oxygen valve has reached its maximum opening and the auxiliary air valve is closed tight and sealed against the admission of any air into the apparatus.

While the apparatus is at ground level and up to an altitude of approximately 10,000 feet no oxygen is delivered from the oxygen chamber 11 to the mixing chamber 13 and during this time the main air valve 42 is opened and only outer air is drawn through the apparatus and supplied to the aviator wearing the mask by the suction of his inhalation. A considerable economy at this time is effected in the use of oxygen from the reserve supply.

During the rise of the apparatus with the aviator from the altitude of, say, 10,000 feet to 33,000 feet the oxygen valve and the main and auxiliary air valves are all open more or less due to the changes in pressure on the aneroid and the inhalation of the aviator in the higher altitudes, whereby air and oxygen are mixed in varying proportions and supplied to the aviator. As a result the oxygen is diluted by air to suit the requirements of the different altitudes, and thus effects a saving in the consumption of oxygen from the reserve supply.

The spring loaded main air inlet valve creates a balance between the suction needed to operate the breathing apparatus 18 and the atmospheric air flowing into this apparatus under the negative pressure created inside of the apparatus by the suction of the aviator and thus prevents the formation of a gaseous mixture for breathing purposes which is too lean in oxygen. This main air valve is very sensitive and opens under a negative pressure of approximately 4 to 7 millimeters of water. This main air valve performs the additional function of a check valve which prevents back flow to the exterior of the apparatus when the aviator exhales.

In the event that a great negative suction is created by the aviator the spring load relief valve is opened automatically and permits the flow of oxygen directly from the oxygen inlet chamber to the mixture outlet chamber for use by the aviator independently of the controlling effect of the aneroid. This emergency valve is spring loaded to approximately 22 to 30 millimeters of water and has a flow of approximately 20 to 30 liters with a suction of 36 to 38 millimeters of water.

During ordinary use a man's normal rate of inhalation would be between 15 to 20 liters per minute while inhaling. The oxygen and auxiliary air mixing valves plus the loaded main air supply valve controlling the inlet from the external atmosphere provide a uniform gaseous mixture for breathing purposes within the required tolerances at an altitude of from 0 to 35,000 feet.

In case of excitement, injury or some other distress, causing the aviator to breathe rapidly and heavily, the emergency or relief valve will open automatically and increase the percentage of oxygen in the breathing mixture.

From the foregoing it will now clearly appear that this invention permits of greater economy in the use of oxygen because oxygen is cut off and only air is admitted at ground level and at lower altitudes. It also cuts off all air and admits only oxygen at the higher altitudes so as to ensure an ample supply of oxygen when most needed and it also causes a dilution of oxygen with air during the intermediate altitudes in proportions

which are varied automatically in accordance with the respective altitude, thereby supplying the aviator at all times with the amount of oxygen necessary for insuring his comfort and safety.

We claim as our invention:

1. An air and oxygen controlling apparatus for aviators, comprising a body having an oxygen inlet chamber, an air inlet chamber and an air and oxygen mixture outlet chamber, and pressure responsive valve means for controlling communication between said oxygen inlet and air inlet chambers and said mixture outlet chamber including an air port leading from said air inlet chamber to said mixture chamber and provided with an air valve seat, an oxygen port leading from said oxygen inlet chamber to said mixture chamber and having an oxygen valve seat, an air valve movable toward and from said air valve seat, an oxygen valve movable toward and from said oxygen valve seat said air and oxygen valve seats being of annular form and facing each other, and said air and oxygen valves having the form of disks which are arranged side by side, an aneroid arranged in said oxygen inlet chamber and having an outer fixed head secured to said body and also having an inner movable head, a valve stem having a threaded rear end adjustably connected with said front head of the aneroid and also having a threaded front end which passes through the center of said valves, a shoulder on said stem engaging said oxygen valve, a screw nut arranged on the front end of said stem and engaging said air valve, a spacing washer arranged between said valves, and a detent spring interposed between the inner head of said aneroid and a shoulder on said valve stem.

2. An air and oxygen controlling apparatus for aviators, comprising a body having an oxygen inlet chamber provided with an inner wall containing an inwardly facing shoulder and an air inlet chamber having an inner wall provided with an outwardly facing shoulder, an oxygen valve ring seated on said inwardly facing shoulder and provided with a valve seat, an air valve ring seated on said outwardly facing shoulder and provided with an inwardly facing valve seat which opposes the seat of said oxygen valve ring, means fastening said air valve ring to its re-

spective wall, oxygen and air valves movable respectively toward and from the seats on said oxygen and air valve rings, an aneroid arranged in said oxygen inlet chamber and operatively connected with said oxygen and air valves, and a retaining spacer interposed between said oxygen valve ring and said air valve ring.

3. An air and oxygen controlling apparatus for aviators, comprising a body having an oxygen inlet chamber provided with an inner wall containing an inwardly facing shoulder and an air inlet chamber having an inner wall provided with an outwardly facing shoulder, an oxygen valve ring seated on said inwardly facing shoulder and provided with a valve seat, an air valve ring seated on said outwardly facing shoulder and provided with an inwardly facing valve seat which opposes the seat of said oxygen valve ring, means fastening said air valve ring to its respective wall, oxygen and air valves movable respectively toward and from the seats on said oxygen and air valve rings, an aneroid arranged in said oxygen inlet chamber and operatively connected with said oxygen and air valves, and a retaining spacer interposed between said oxygen valve ring and said air valve ring and having the form of a helical spring.

4. An air and oxygen controlling apparatus for aviators, comprising a body having an oxygen inlet chamber, an air inlet chamber and an air and oxygen mixture outlet chamber, oxygen valve means responsive to variations in pressures in the oxygen inlet chamber for controlling the flow of oxygen from the oxygen inlet chamber to said mixture chamber, and air valve means for controlling the flow of air from the external atmosphere into said air inlet chamber including an air valve ring secured to said body and provided with an inwardly facing annular valve seat, a disk valve movable toward and from said seat, and spring means for holding said disk valve yieldingly in engagement with said valve seat comprising a spring arm secured at its outer end to said ring and provided at its inner end with a reversely bent lip, and a pin connecting said lip with the central part of said disk valve.

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